

## § 1065.270

CH<sub>4</sub>, as described in § 1065.265, use a reference procedure based on a gas chromatograph for comparison with any proposed alternate measurement procedure under § 1065.10.

(b) *Component requirements.* We recommend that you use a gas chromatograph that meets the specifications in Table 1 of § 1065.205, and it must also meet the linearity verification in § 1065.307.

### NO<sub>x</sub> MEASUREMENTS

## § 1065.270 Chemiluminescent detector.

(a) *Application.* You may use a chemiluminescent detector (CLD) to measure NO<sub>x</sub> concentration in raw or diluted exhaust for batch or continuous sampling. We generally accept a CLD for NO<sub>x</sub> measurement, even though it measures only NO and NO<sub>2</sub>, when coupled with an NO<sub>2</sub>-to-NO converter, since conventional engines and aftertreatment systems do not emit significant amounts of NO<sub>x</sub> species other than NO and NO<sub>2</sub>. Measure other NO<sub>x</sub> species if required by the standard-setting part. While you may also use other instruments to measure NO<sub>x</sub>, as described in § 1065.272, use a reference procedure based on a chemiluminescent detector for comparison with any proposed alternate measurement procedure under § 1065.10.

(b) *Component requirements.* We recommend that you use a CLD that meets the specifications in Table 1 of § 1065.205. Note that your CLD-based system must meet the quench verification in § 1065.370 and it must also meet the linearity verification in § 1065.307. You may use a heated or unheated CLD, and you may use a CLD that operates at atmospheric pressure or under a vacuum. You may use a CLD that has compensation algorithms that are functions of other gaseous measurements and the engine's known or assumed fuel properties. The target value for any compensation algorithm is 0.0% (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.

(c) *NO<sub>2</sub>-to-NO converter.* Place upstream of the CLD an internal or external NO<sub>2</sub>-to-NO converter that meets the verification in § 1065.378. Configure

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the converter with a bypass to facilitate this verification.

(d) *Humidity effects.* You must maintain all CLD temperatures to prevent aqueous condensation. To remove humidity from a sample upstream of a CLD, use one of the following configurations:

(1) Connect a CLD downstream of any dryer or chiller that is downstream of an NO<sub>2</sub>-to-NO converter that meets the verification in § 1065.378.

(2) Connect a CLD downstream of any dryer or thermal chiller that meets the verification in § 1065.376.

(e) *Response time.* You may use a heated CLD to improve CLD response time.

## § 1065.272 Nondispersive ultraviolet analyzer.

(a) *Application.* You may use a nondispersive ultraviolet (NDUV) analyzer to measure NO<sub>x</sub> concentration in raw or diluted exhaust for batch or continuous sampling. We generally accept an NDUV for NO<sub>x</sub> measurement, even though it measures only NO and NO<sub>2</sub>, since conventional engines and aftertreatment systems do not emit significant amounts of other NO<sub>x</sub> species. Measure other NO<sub>x</sub> species if required by the standard-setting part.

(b) *Component requirements.* We recommend that you use an NDUV analyzer that meets the specifications in Table 1 of § 1065.205. Note that your NDUV-based system must meet the verifications in § 1065.372 and it must also meet the linearity verification in § 1065.307. You may use a NDUV analyzer that has compensation algorithms that are functions of other gaseous measurements and the engine's known or assumed fuel properties. The target value for any compensation algorithm is 0.0% (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.

(c) *NO<sub>2</sub>-to-NO converter.* If your NDUV analyzer measures only NO, place upstream of the NDUV analyzer an internal or external NO<sub>2</sub>-to-NO converter that meets the verification in § 1065.378. Configure the converter with a bypass to facilitate this verification.

(d) *Humidity effects.* You must maintain NDUV temperature to prevent

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## § 1065.295

aqueous condensation, unless you use one of the following configurations:

(1) Connect an NDUV downstream of any dryer or chiller that is downstream of an NO<sub>2</sub>-to-NO converter that meets the verification in § 1065.378.

(2) Connect an NDUV downstream of any dryer or thermal chiller that meets the verification in § 1065.376.

### O<sub>2</sub> MEASUREMENTS

#### § 1065.280 Paramagnetic and magnetopneumatic O<sub>2</sub> detection analyzers.

(a) *Application.* You may use a paramagnetic detection (PMD) or magnetopneumatic detection (MPD) analyzer to measure O<sub>2</sub> concentration in raw or diluted exhaust for batch or continuous sampling. You may use O<sub>2</sub> measurements with intake air or fuel flow measurements to calculate exhaust flow rate according to § 1065.650.

(b) *Component requirements.* We recommend that you use a PMD/MPD analyzer that meets the specifications in Table 1 of § 1065.205. Note that it must meet the linearity verification in § 1065.307. You may use a PMD/MPD that has compensation algorithms that are functions of other gaseous measurements and the engine's known or assumed fuel properties. The target value for any compensation algorithm is 0.0% (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.

### AIR-TO-FUEL RATIO MEASUREMENTS

#### § 1065.284 Zirconia (ZrO<sub>2</sub>) analyzer.

(a) *Application.* You may use a zirconia (ZrO<sub>2</sub>) analyzer to measure air-to-fuel ratio in raw exhaust for continuous sampling. You may use O<sub>2</sub> measurements with intake air or fuel flow measurements to calculate exhaust flow rate according to § 1065.650.

(b) *Component requirements.* We recommend that you use a ZrO<sub>2</sub> analyzer that meets the specifications in Table 1 of § 1065.205. Note that your ZrO<sub>2</sub>-based system must meet the linearity verification in § 1065.307. You may use a Zirconia analyzer that has compensation algorithms that are functions of other gaseous measurements and the engine's known or assumed fuel properties. The target value for any com-

pensation algorithm is 0.0% (that is, no bias high and no bias low), regardless of the uncompensated signal's bias.

### PM MEASUREMENTS

#### § 1065.290 PM gravimetric balance.

(a) *Application.* Use a balance to weigh net PM on a sample medium for laboratory testing.

(b) *Component requirements.* We recommend that you use a balance that meets the specifications in Table 1 of § 1065.205. Note that your balance-based system must meet the linearity verification in § 1065.307. If the balance uses internal calibration weights for routine spanning and linearity verifications, the calibration weights must meet the specifications in § 1065.790. While you may also use an inertial balance to measure PM, as described in § 1065.295, use a reference procedure based on a gravimetric balance for comparison with any proposed alternate measurement procedure under § 1065.10.

(c) *Pan design.* We recommend that you use a balance pan designed to minimize corner loading of the balance, as follows:

(1) Use a pan that centers the PM sample on the weighing pan. For example, use a pan in the shape of a cross that has upswept tips that center the PM sample media on the pan.

(2) Use a pan that positions the PM sample as low as possible.

(d) *Balance configuration.* Configure the balance for optimum settling time and stability at your location.

#### § 1065.295 PM inertial balance for field-testing analysis.

(a) *Application.* You may use an inertial balance to quantify net PM on a sample medium for field testing.

(b) *Component requirements.* We recommend that you use a balance that meets the specifications in Table 1 of § 1065.205. Note that your balance-based system must meet the linearity verification in § 1065.307. If the balance uses an internal calibration process for routine spanning and linearity verifications, the process must be NIST-traceable. You may use an inertial PM balance that has compensation algorithms that are functions of other